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SOME RELATIONS BETWEEN THE HABITATS OF MOSSES AND THEIR STRUCTURE.

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Fifteen years of study of North American mosses both in the field and herbarium have convinced the writer that many peculiarities of moss structure are a direct result of peculiarities of habitat. It is, of course, extremely difficult to determine whether in any given case a peculiarity in habitat correlated with a peculiarity of structure has a causal relation or is merely a coincidence. Besides it is difficult to find such relationships that are not more or less obscured by exceptions to the general run of facts. The present article is put forth as tentative and suggestive, yet it seems to the author that it certainly contains much of truth, possibly interwoven with more or less misinterpretation.

There are numerous cases where mosses of widely different relationships but of a common habitat, possess strikingly similar characteristics. These similarities must often be due to similar conditions of life. The fact that this has not always been recognized has led to many classifications not at all natural, as for instance the *Cleistocarpi*.

FIRST let us consider the sporophyte. Here the most striking fact to me is that mosses growing largely or wholly on tree trunks have erect capsules. Here we have many species of *Orthotrichaceae*, *Leucodontaceae*, *Fabroniaceae*, *Neckeraceae*, *Leskeaceae* and *Hypnaceae*. An examination of some cases of erect capsules in the *Hypnaceae* illustrates this relation most strikingly. Species classed with *Homalothecium* (*Euhomalothecium* of Cardot) are not separable from *Camptothecium* except by sporophyte characters. In *Brachythecium* the erect-capsuled species, *B. acuminatum* (Hedw.) Kindb., *B. cyrtophyllum* Kindb. etc., are largely tree-growing. I believe it is not the substratum but the position of growth that causes this modification of the capsule so that we find a similar modification in species that grow largely on faces of cliffs or in fissures of cliffs, e. g. *Brachythecium collinum* and its allies. *Pylaisia* is certainly closely related to many species of *Hypnum* having curved capsules, and *Amblystegium adnatum*, largely a tree-growing species, has nearly erect capsules. Many more illustrations could be given but the above will suffice.

Let us consider in what way this growing on a more or less vertical substratum could affect the structure of the capsule. It has undoubtedly been brought about through the medium of spore dispersal. We shall find that very few mosses with erect capsules have complete double peristomes, even if most closely related to others having typically developed double peristomes with segments and cilia, e. g. *Pylaisia*, *Brachythecium acuminatum* and *Homalothecium*. The *Orthotrichaceae* as a rule have only a trace of the inner peristome.

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The complete double peristome is a device to prevent the too rapid escape of the spores in mosses with pendent or strongly cernuous capsules, but mosses growing on trees or cliffs can shed the spores much more freely and without waste as the much greater distance above the ground insures freer and more certain access to air currents. Hence imperfect peristomes would be no bar to reproduction, and natural selection would not keep the peristome up to its full perfection. In vertical erect capsules many spores must fail to escape at the most advantageous time or even at all until moisture or old age have rendered them valueless for reproduction. Hence a curved and cernuous or a drooping capsule with the mouth well guarded by a complete peristome would insure the greatest percentage of reproduction in mosses with a vertical seta, but if the substratum be vertical the erect capsule is horizontal or even pendent, as in *Neckera*, and the spores find easy and ready exit.

I am not unaware of exceptions to this line of reasoning, *Hypnum reptile* with a tree habitat and curved capsules, or many species of *Entodon* with horizontal habitat and erect capsules with imperfect peristomes, but there must of necessity be some cases of progressing adaptation and of the survival of a character after a change of habitat has rendered it more or less unsuited to new conditions.

There are undoubtedly many mosses of a more primitive type of peristome in which the erect sporophyte is the primitive condition and these as a class may grow on almost any substratum, e. g. *Georgia*, *Catharinea*, many of the *Tortulaceae*, *Dicranaceae* and perhaps the *Grimmiaceae*. A second apparently similar case of habitat modification is found in the so-called *Cleistocarpi* and many gymnostomous species. These as a rule grow on moist soil, either bare from fresh disturbance or scantily covered with other vegetation. They are usually annual and develop their spores in the spring while the soil is moist, disappearing in many cases during the drier part of the season, though under favorable conditions it seems probable that the protonema may persist for more than one season. The whole subject of the duration of these forms is imperfectly known and more observation is needed. The leaves of these mosses are usually thin and soft although *Astomum* and *Weisia* still retain the leaf-structure of the *Tortulaceae* and are probably not annuals. Some of these mosses may possibly be primitive types but most are degenerate members of families of a high degree of development. Such are *Sphaerangium*, *Phascum*, *Pleuridium*, *Acaulon* and *Bruchia* of the *Cleistocarpi* and *Astomum*, *Physcomitrium*, *Aphanoregma* and *Pottia* species, of the gymnostomous forms. Just how or to what extent the habitat of these degenerate forms has induced the common character is not clear but I believe there is a causal relation.

Second. Modifications of the gametophyte. Mosses whose habitat is strongly xerophytic for any considerable portion of the time have small cells and very thick cell walls, e. g. *Grimmia*, *Orthotrichum*, many of the *Tortulaceae* and *Leskeaceae*. This condition obviously retards the escape of water. Many of the larger mosses like some species of *Polytrichum* growing in places where seed plants have abundant moisture are at times thoroughly

dried out by reason of their limited absorption area or lack of vascular system or both. It seems probable that the large papillae found on the surface of the cells of many species may be but an added protection against dessication, e. g. *Orthotrichum*, *Andreaea*, *Thuidium*, *Anomodon* and *Thelia*. The fact that such species as *Anomodon rostratus* and *Thuidium delicatulum* grow in moist situations does not outweigh the fact that these genera as a whole are xerophytic. The papillae formed by the projecting angles of the leaf-cells as in *Bryhnia* Kaurin belong in a wholly different category. We have a few cases of xerophyte species with papillose leaf-cells in genera which do not as a rule have papillae, e. g, *Dicranum spurium* and *D. condensatum*.

While considering this topic it is well to call to mind the fact that many mosses that are drenched with moisture much of the time are at others exposed to drying winds of high velocity and great absorbing power. Plants growing on exposed rocks in mountains furnish a good illustration of this. *Andreaea petrophila* grows freely all over Mt. Mansfield, Vermont, at an altitude of 4000 feet and over, but fruits freely in sheltered spots only. The evidences of the importance of water supply and retention in the mosses are so abundant and conclusive that further enumeration is not needed here. It is entirely probable that the failure of any terrestrial plants below the vascular cryptogams to attain commanding size is due to the lack of ability to supply and retain sufficient moisture for a greater development.

All careful students of our mosses have noted the large number of quadrate, thick-walled alar cells found in pleurocarpous mosses growing on the bark of trees and similar xerophytic habitats even in genera or families in which such cells are not usually numerous, e. g. *Pylaisia*, *Eurhynchium myosuroides* Schimp., *Isothecium*, *Rhytidium rugosum* (L.) Kindb. Also note that *Pylaisia Schimperi* (Hedw.) Card. growing in dry exposed situations such as old apple trees has a much larger number of these cells than *P. intricata* (Hedw.) Cardot (*P. velutina* of authors) which grows in moist woods.

On the other hand the alar cells of aquatic or subaquatic pleurocarpous species tend to become enlarged and inflated, e. g. *Drepanocladus* (Harpidium), *Scleropodium obtusifolium*, *Campylium stellatum*, *Brachythecium rivulare*, etc. In these examples it will be noted that the other leaf-cells are mostly exceedingly long and narrow making the contrast much more striking The meaning of this modification is very obscure. The almost universal differentiation of alar and basal cells in mosses is possibly due to the fact that their part in photosynthesis is very small and they are the ones most free to respond to other than light relations.

It may possibly be that these thin walled and inflated alar cells of aquatic mosses are structures facilitating osmosis between the contents of the cells and the water outside. It is also possible that scarious leaf bases like those of *Polytrichum* may be water absorbing organs. It is pretty generally admitted that the large thin-walled cells of the leaves of Sphagnum serve to absorb and retain water for by means of these cells the plant is almost sponge-like in its power to absorb and retain moisture.

This entire subject is one of the greatest importance to the systematic bryologist and the preceding suggestions only touch upon its fringe. Had its importance been recognized by earlier writers not only would the *Cleistocarpi* never have been treated as a separate group, but *Grimmia* and *Orthotrichum* would never have been put in the same family or *Homalothecium*, *Pylaisia*, *Orthothecium* and *Entodon* been closely associated.

Sometime later I hope to be able to add to the above suggestions and to give an extensive list of species confirming these suggestions, together with such exceptions as I can find.

October, 1908. Brooklyn, New York.

ASA GRAY.

November 18, 1810—January 30, 1885.

The portrait herewith presented marks the recent publication of the seventh edition of the long familiar "Gray's New Manual of Botany." This volume is illustrated, some groups more fully than others, and rearranged to follow in large part that of Engler and Prantl, but it is still in all essentials the beloved book of our youthful days. It is edited by Benjamin Lincoln Robinson, Asa Gray Professor of Systematic Botany at Harvard University, and Merritt Lyndon Fernald, Assistant Professor in the same University, and published by the American Book Co.

We had hoped to have a biographical sketch to offer at this time but our space is full and we can only refer our readers to the interesting account given by Walter Deane of the life and death of this "venerable Priest" of Botany, in the Bulletin of the Torrey Botanical Club, Vol. XV., No. 3, March, 1888, from which number our plate is reproduced.

A PRELIMINARY LIST OF HEPATICS FOUND IN THE VICINITY OF BALTIMORE.

CHARLES C. PLITT.

Ricciaceae.

1. *Riccia fluitans* L. (terrestrial form).
   In early spring, after the snows and ice have disappeared, and the streams are beginning to subside, this pretty little hepatic will be found appearing in great numbers upon areas of the alluvial soil along the river, sometimes, too, extending into the cultivated fields, some distance from its banks.

Marchantiaceae.

2. *Reboulia hemisphaerica* (L.) Raddi.
   This is a fairly common hepatic in our limestone regions. I had become so accustomed to seeing it only in such régions, that I was very much surprised to find it once in a shady spot along a roadside in our Coastal Plain.